EXHIBIT B

with citric acid solution **30** and a lower chamber **31** containing a mass of sodium bicarbonate **32** (other effervescent couples could of course be used). A lower chamber **31** communicates with a pumping chamber **33** in cylindrical body **12** defined between the gas generator **17** and the piston **13**.

Upper chamber **29** is bounded by a penetrable laminated foil membrane **34**. A cutting member **35** is provided in the lower chamber **31** so as to rest against the membrane **34**. The membrane **34** must create a barrier between the upper and lower chambers **29,31** yet be penetrable. The upper and lower chambers **29,31** are connected together by a circumferential seal **36**.

The upper chamber **29** is provided with a flexible peripheral portion **37** adjacent to the seal **36**. Because of its flexibility, the peripheral portion **37** imparts a small amount of freedom of movement of upper chamber **29** towards lower chamber **31**. Therefore, if the gas generator **27** is mechanically compressed, the upper chamber **29** moves towards the lower chamber **31** resulting in the penetration of the foil membrane **34** by the cutting member **35**.

Downward pressure on the barrel **11** results in the situation shown in FIG. **5**. The sleeve **20** pushes the flange **27** and hence the cylindrical body **12** and the gas generator **17** upwards within the barrel **11**. When the gas generator **17** reaches the top of barrel **11** it is compressed. This compression causes cutting member **35** to penetrate foil membrane (not visible in FIG. **5**), releasing citric acid **30** into contact with sodium bicarbonate **32**. This results in the immediate generation of carbon dioxide causing the pumping chamber **33** to become pressurised, which in turn drives the piston **13** downwards to deliver the liquid **14** from cylindrical body **12** to the injection site **25** via the needle **15**.

When delivery has been completed (this may suitably take of the order of 3–5 seconds, although longer or shorter times can be achieved if required), gas generation will generally not have been completed: a surplus of reactive gas generating materials is provided so as to ensure completion of delivery. In order to prevent any dangerous pressure build up a release valve **38** is provided on the gas generator **17**. The release valve **38** opens when pressure reaches a predetermined level. Thus, release valve **38** is also actuated by any blockage in delivery.

When delivery has been completed, the barrel **11** is removed from the injection site **25**. As the pressure on the barrel **11** is relieved, the spring **22** pushes the sleeve **20** from the second position (FIG. **5**) back to the first position (FIG. **6**). Thus, the needle **15** is concealed even before the sleeve **20** has left the injection site **25**. For severely needlephobic patients, any sight of the needle must be avoided if possible, and for safety reasons, it is highly preferable that the needle is never exposed. As a result of the slot **23** and the location of the peg **24** in the first position (as shown in FIG. 7D), the sleeve **20** is locked in the first position when it returns from the second position and the pressure of the spring **22** prevent it from returning to the second position, as will be discussed in more detail below.

FIGS. 7A–7D illustrate the operation of the safety locking mechanism by showing the position of the peg **24** (mounted in the interior of barrel **11**) in the slot **23** formed in the sleeve **20**, at four stages of the delivery procedure, with FIGS. 7A–7D corresponding to FIGS. **3–6**, respectively.

As indicated previously, the sleeve **20** is biased to the first position (FIGS. **3** and 7A) by a coil spring **22**, illustrated in FIG. **8**. The ends of spring **22** form two outward projections **39**, one of which engages barrel **11** and the other of which engages the sleeve **20**. In addition to providing an axial biasing, spring **22** rotationally biases the sleeve **20** relative to the barrel **11** towards an equilibrium position, but the slot **23** and peg **24** constrain the relative rotation of the barrel **11** and the sleeve **20**.

The equilibrium position is indicated in FIGS. 7A–7D by a dotted line, which is the equilibrium position of the peg **24** in barrel **11** relative to the sleeve **20**. Accordingly, in FIGS. 7A–7C the peg **24** is to the left of the relaxed equilibrium position (in the view shown), resulting in a rotational bias of the sleeve **20** relative to the barrel **11** which would cause the peg to move to the right. In FIG. 7D, the peg is effectively at the equilibrium position.

As the peg **24** is constrained in the slot, it has to follow the path illustrated in FIGS. 7A–7C as the sleeve moves from the first position (FIG. 7A) to the second position (FIG. 7C). When delivery is completed and the pressure on the barrel is released, the sleeve is axially moved from the second position (FIG. 7C) to the first position. The rotational biasing of the spring **22**, however, causes the peg **24** to travel into the right-hand arm **40** of the slot **23** (FIG. 7C), rather than the left-hand arm **41** in which it started. When the sleeve **20** has moved most of the way back towards the first position (just before the point illustrated in FIG. 7D), the peg **24** is biased to move leftwards (as seen in the view of FIGS. 7A–7D) and passes the top right-hand corner **42** of the slot **23**. At this point the peg is free to move leftwards, and thus it springs to the position shown in FIG. 7D, i.e. the barrel **11** and the sleeve **20** rotate relative to one another under the influence of the spring **22** to reach the FIG. 7D position.

When the peg **24** is in the position shown in FIG. 7D it is effectively trapped, and any attempt to move the sleeve **20** axially relative to the barrel **11** results in the peg **24** being stopped in the small notch **43**. Accordingly, after a single reciprocation from the first position to the second position and back to the first position, the sleeve **20** is locked and the needle **22** is permanently concealed.

FIG. **9** shows the syringe **10** in perspective view before use. Thus, barrel **11**, sleeve **20**, and needle cover **16** can be seen. Also visible are slot **23** and the position of pin **24**. A further feature is a transparent window **44** which allows the user to see when the delivery of liquid is complete so that the syringe **10** can be removed.

The needle **15** is preferred to extend from the sleeve by 1–3 mm, most preferably by 1 mm in length. In addition the ratio of citric acid to sodium bicarbonate in the gas generator should be sufficient to preferably generate a delivery pressure of approximately **2** atmospheres. This enables the syringe **10** to deliver the liquid **14** to the user automatically at a low pressure and with a reduced risk of injury.

FIG. **10** shows a first alternative embodiment of the present invention. It is similar to the syringe described in detail above except that it has a needle cover different from that shown in FIG. **1**. FIG. **10** shows a needle cover **40** shaped to fit over the needle **15**. The needle cover also has a radial groove **41** located at the opposed end of the needle on the exterior of the cover. The needle cover **40** and sleeve **20** are covered by a cap **42**. The cap **42** has an interior groove **43** that matingly receives the radial groove of the needle cover **40** when the cap is placed over the needle cover **40** and sleeve **20**. The cap **42** maintains the sterility of the needle **15** until removal of the cap. When the cap **42** is pulled off the syringe prior to use, the mating pair of grooves cause the needle cover **40** to be pulled off at the same time. When the cap **42** is placed back over the sleeve **20**, the needle cover **40** is also placed over the needle **15** to further avoid contamination and/or leakage of any remaining residue left within the syringe **10**.

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FIG. 11 shows a second alternative embodiment of the present invention. FIG. 11 is similar to the embodiment shown in FIG. 10 but has a different cap 44 and needle cover 45. The cap 44 has an outer lip 46 that rests over the open end 19 of the barrel 11. The needle cover 45 is cylindrical in shape and covers the needle 15 and maintains its sterility until use. Prior to use, the user must first remove the cap 44, and then remove the needle cover 45. After use, the user must replace the needle cover 45 and then the cap 44 separately.

It will be appreciated that the embodiments discussed above are preferred embodiments, falling within the scope of the appended claims, and that various alternative embodiments are contemplated.

For example, other chemically reactive materials other than citric acid and sodium bicarbonate may be used in connection with the gas generator of the present invention. Other mechanisms other than the coil spring 22 may be used to exert upward pressure on the barrel 11 and activate the gas generator 17. Such alternative mechanisms include the use of any elastic or resilient member.

It is further appreciated that the present invention may be used to deliver a number of drugs. The term "drug" used herein includes but is not limited to peptides or proteins, hormones, analygesics, anti-migratine agents, anti-coagulant agents, narcotic antagonists, chelating agents, anti-anginal agnets, chemotherapy agents, sedatives, anti-neoplasticws, prostaglandins and antidiuretic agents.

Typical drugs include peptides, proteins or hormones such as insulin, calcitonin, calcitonin gene regulating protein, atrial natriuretic protein, colony stimulating factor, betaseron, erythrogpoietin (EPO), interferons suchs as α, β or γ interferon, somatropin, somatotropin, somastostatin, insulin-like growth factor (somatomedins), luteinizing hormone releasing hormone (LHRH), tissue plasminogen activator (TPA), growth hormone releasing hormone (GHRH), oxytocin, estradiol, growth hormones, leuprolide acetate, factor viii, interleukins such as interleukin-2, and analogues therof; analgesics such as fentanyl, sufentanil, butorphanol, buprenorphine, levorphanol, morphine, hydromorphone, hydrocodone, oxymorphone, methadone, lidocaine, bupivacaine, diclofenac, naproxen, paverin, and analogues thereof; anti-migraine agents such as sumatriptan, ergot alkaloids, and analogues therof; anti-coagulant angents such as heparin, hirudin, and anlogues therof; anti-emetic angets such as scopolamine, ondansetron, domperidone, metoclopramide,a nd analogues thereof; cardiovascular agents, anti-hypertensive agents and vasodilators such as diltiazem, clonidine, nifedipine, varapmil, isosorbide-5-mononitrate, organic nitrates, agents used in treatment of heart disorders, and analogues thereof; sedatives such as benzodiazepines, phenothiozines, and analogues thereof; chelating agents such as deferoxamine, and anlogues thereof; anti-diuretic agents such as desmopressin, vasopressin, and anlogues thereof; anti-anginal agents such as nitroglycerine, and analogues thereof; anti-neoplastics such as fluorouracil, bleomycin, and analogues thereof; prostaglandins and analogues thereof; and chemotherapy agents such as vincristine, and analogues thereof.

What is claimed is:

1. A syringe comprising:

a) a barrel having a liquid drug reservoir therein, the barrel having a first end and a second end;

b) a delivery needle mounted on the first end of the barrel;

c) a gas generator located at the second end of the barrel, the gas generator in communication with the reservoir when the gas generator is activated;

d) gas generation activation means; and

e) a sleeve moveably mounted on the first end of the barrel from a first position where the tip of the needle is concealed by the sleeve to a second position where the tip of the needle is exposed to a third gas generation activation position,

f) whereby when the sleeve is initially pressed against an injection site, the sleeve moves from the first position to the second position, and the tip of the needle penetrates the injection site, and when the sleeve moves from the second position to the third position, it causes activation of the gas generator which drives a liquid from the reservoir into the injection site through the needle.

2. The syringe of claim 1 wherein the gas generator comprises first and second chambers separated by a deformable membrane.

3. The syringe of claim 2 wherein the gas activation means comprises means for puncturing the deformable membrane.

4. The syringe of claim 2 wherein the first and second chambers house the components of an effervescent couple respectively.

5. The syringe of claim 4 wherein at least one of the components of the couple is a liquid.

6. The syringe of claim 4 wherein the components of the effervescent couple are citric acid and sodium bicarbonate respectively.

7. The syringe of claim 1 wherein the gas activation means is activated by movement of the barrel and sleeve from the first position to the second position.

8. The syringe of claim 1 wherein the sleeve is axially biased towards the first position so that it moves to the first position when no pressure is applied to the barrel.

9. The syringe of claim 8 wherein the sleeve is axially biased by means of a coil spring.

10. The syringe of claim 9 wherein the coil spring is disposed between the sleeve and the barrel.

11. The syringe of claim 5 wherein the sleeve is torsionally biased.

12. The syringe of claim 11 wherein the axial and torsional bias are provided by a compression-extension spring under torsional strain.

13. The syringe of claim 1 further comprising locking means such that when the sleeve returns from the second position to the first position the locking means prevents the sleeve from returning to the second position.

14. The syringe of claim 13 wherein the locking means comprises a pair of co-operating formations disposed on the sleeve and the barrel respectively.

15. The syringe of claim 14 wherein the pair of co-operating formations comprises a slot and a member received in the slot respectively.

16. The syringe of claim 1 wherein the needle extends between about 1–3 mm beyond the first end of the barrel.

17. The syringe of claim 1 wherein the needle extends approximately 1 mm beyond the first end of the barrel.

18. The syringe of claim 1 wherein the gas generator generates a pressure of about 2 atmosphere.

19. A method of injecting liquid drug comprising the following steps:

a) providing a barrel having a liquid drug reservoir therein, a delivery needle mounted on the first end of the barrel,

b) locating a gas generator at the second end of the barrel, the gas generator in communication with the reservoir when the gas generator is activated;